Recent progresses in active fault researches and paleoseismology in Japan

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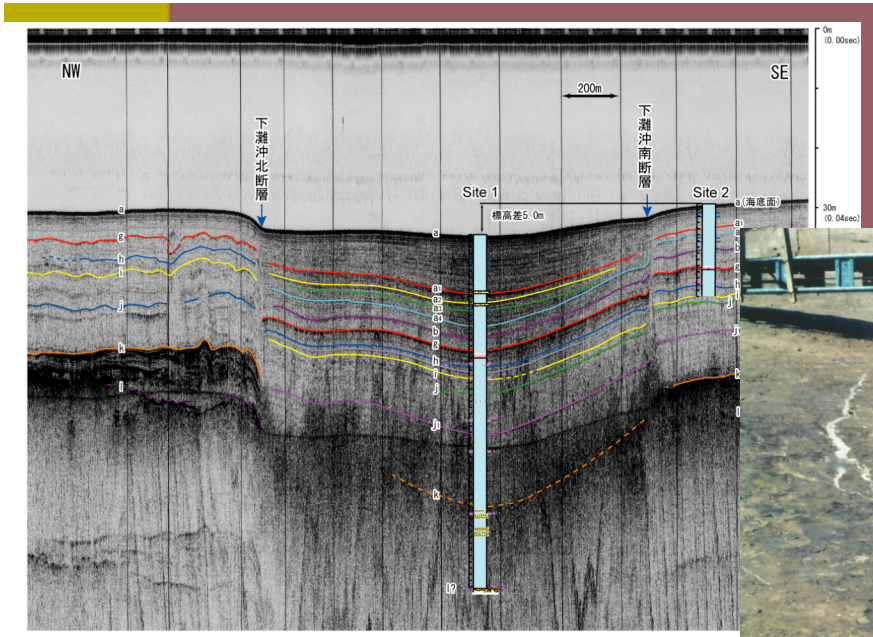
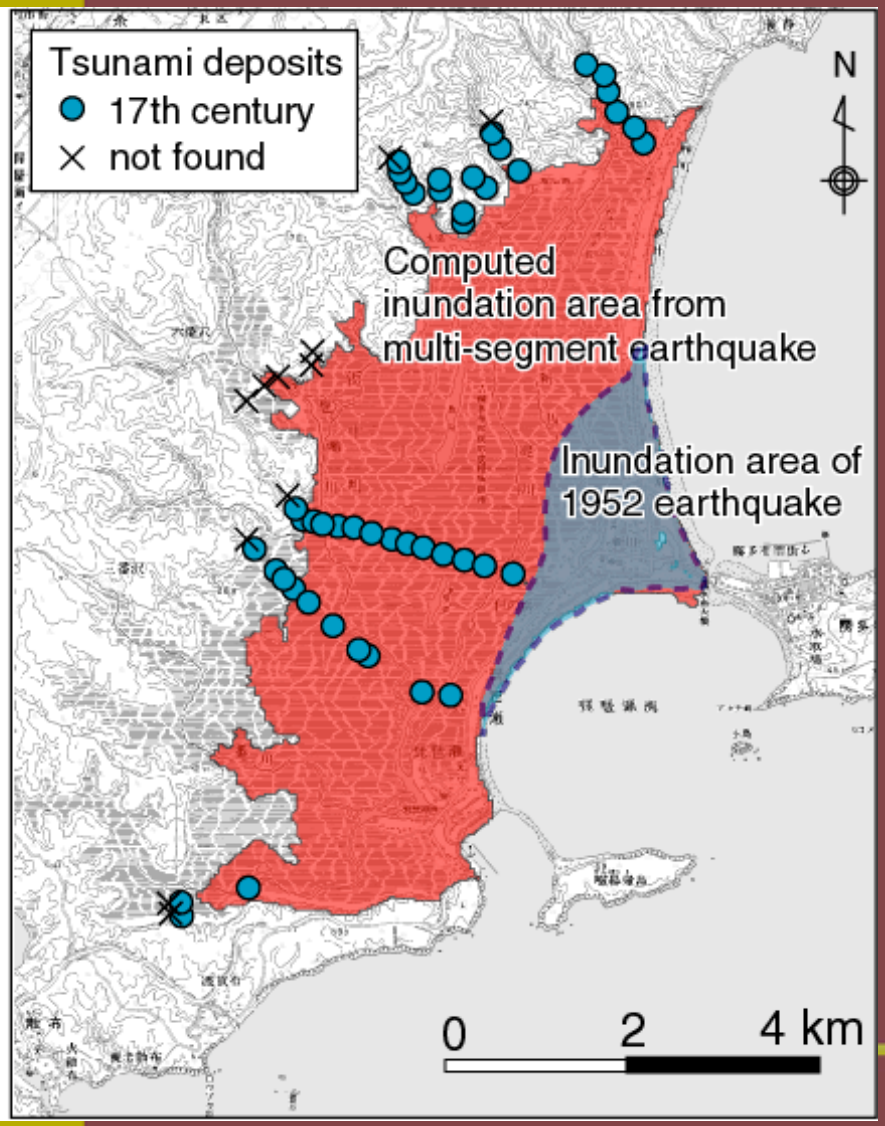
Geological Survey of Japan, AIST

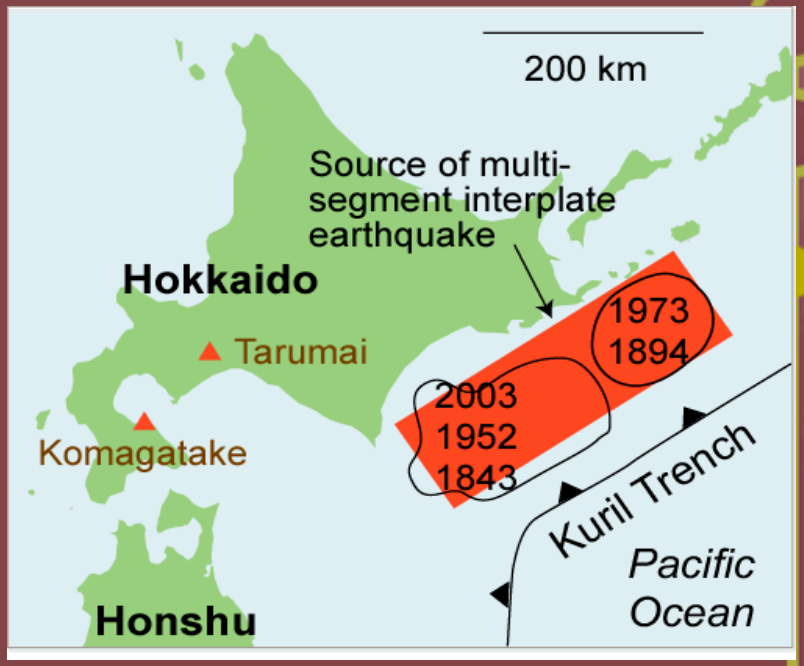
98 Main Active Faults Selected for National Survey



第2図．下灘沖No.51測線におけるソノブローブ音波探査記録と海上ボーリング結果の対比．
Fig. 2. Sedimentary columns of the Site 1 and Site 2 cores projected on the high-resolution acoustic profile of No. 51 line.

Tsunami deposits from multi-segment earthquake along Kuril trench





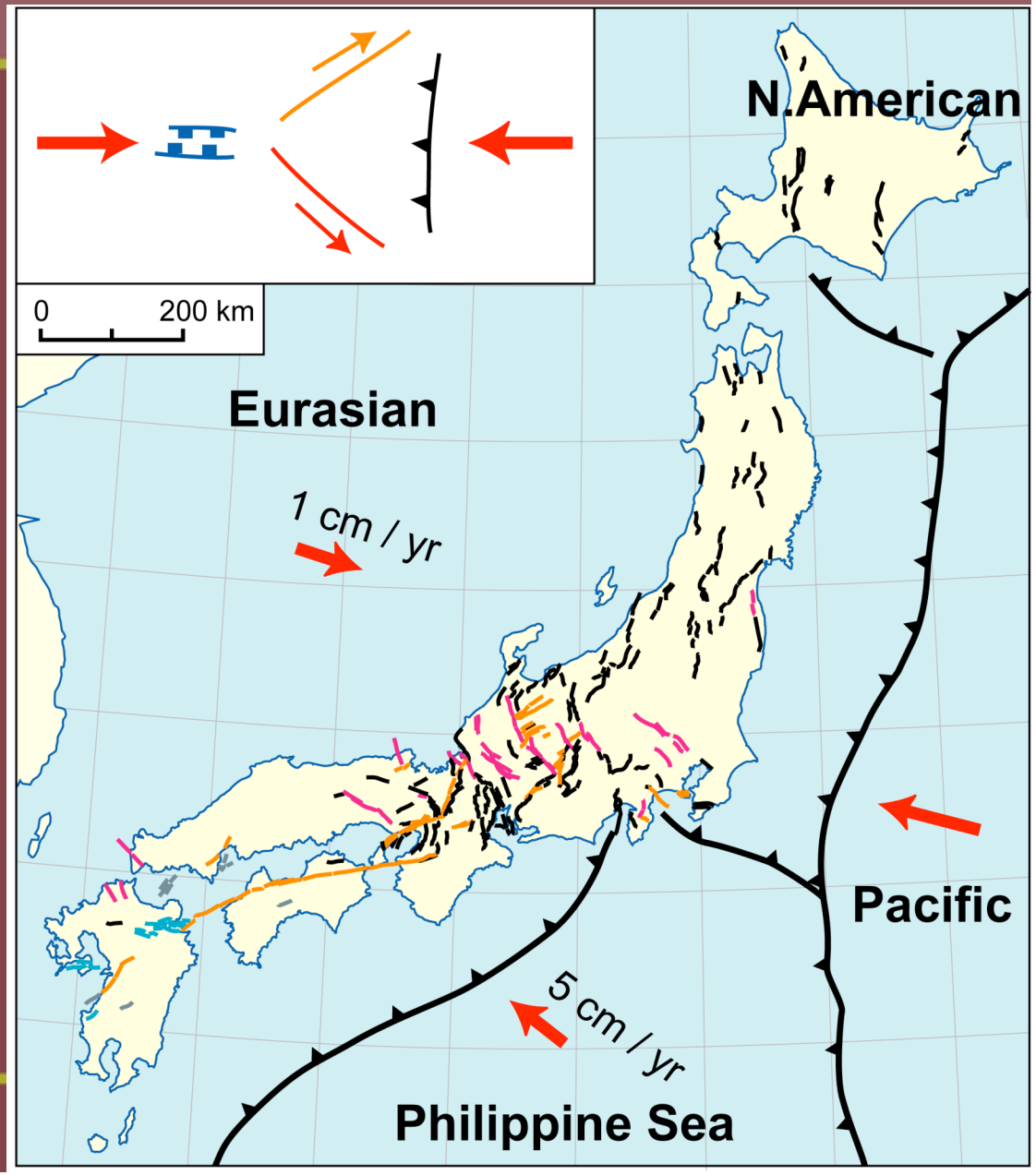
Unusually large tsunamis
every ~ 500 years
the last event 17th century

Nanayama et al.
(2003, Nature)

Active Faults inland Japan

- ca. 400 paleoseismological sites
- Tens of thousands of reference sites for slip

- **Active Fault Database**

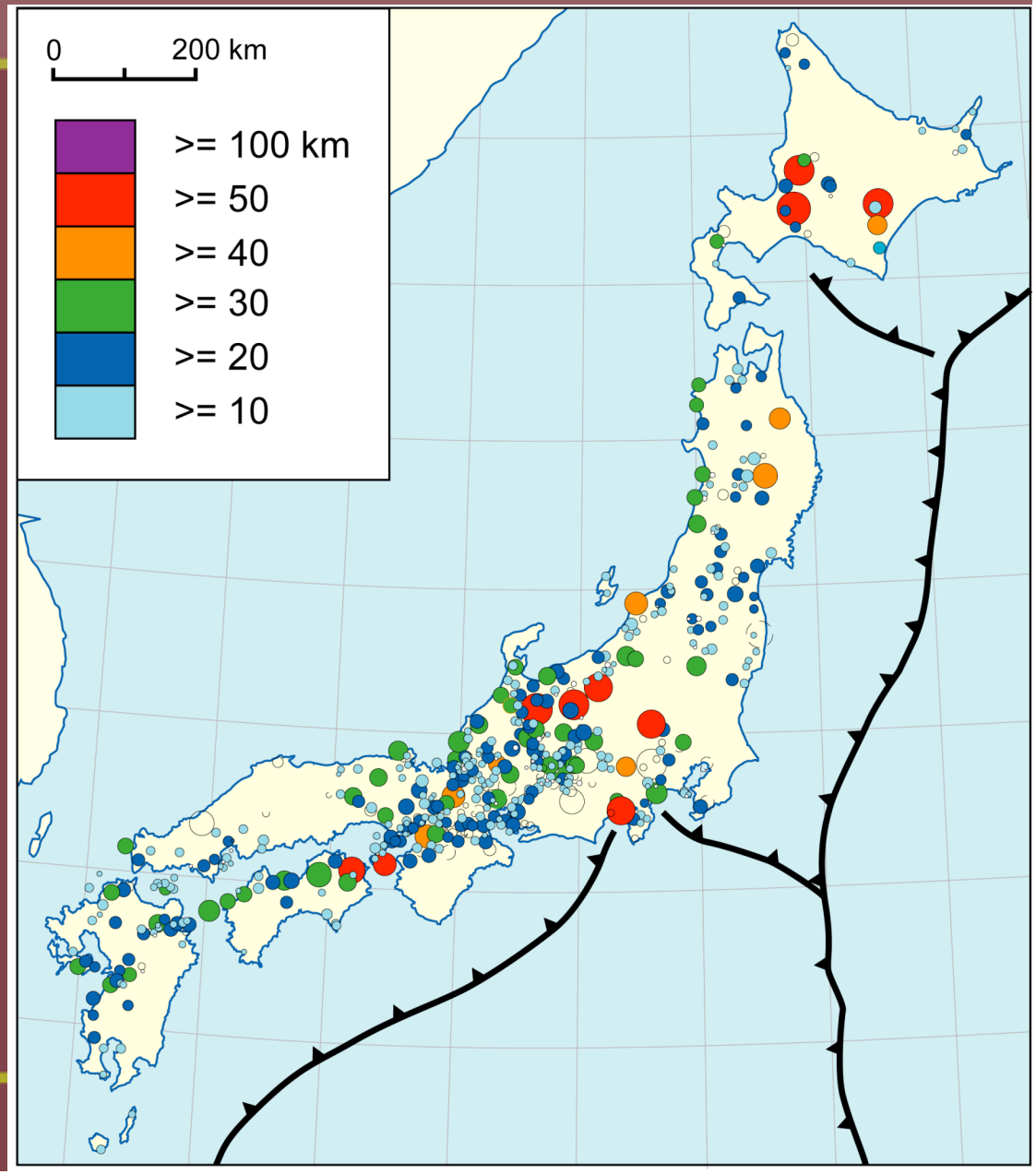


Behavioral-Segments in Japan - **Fault Length**

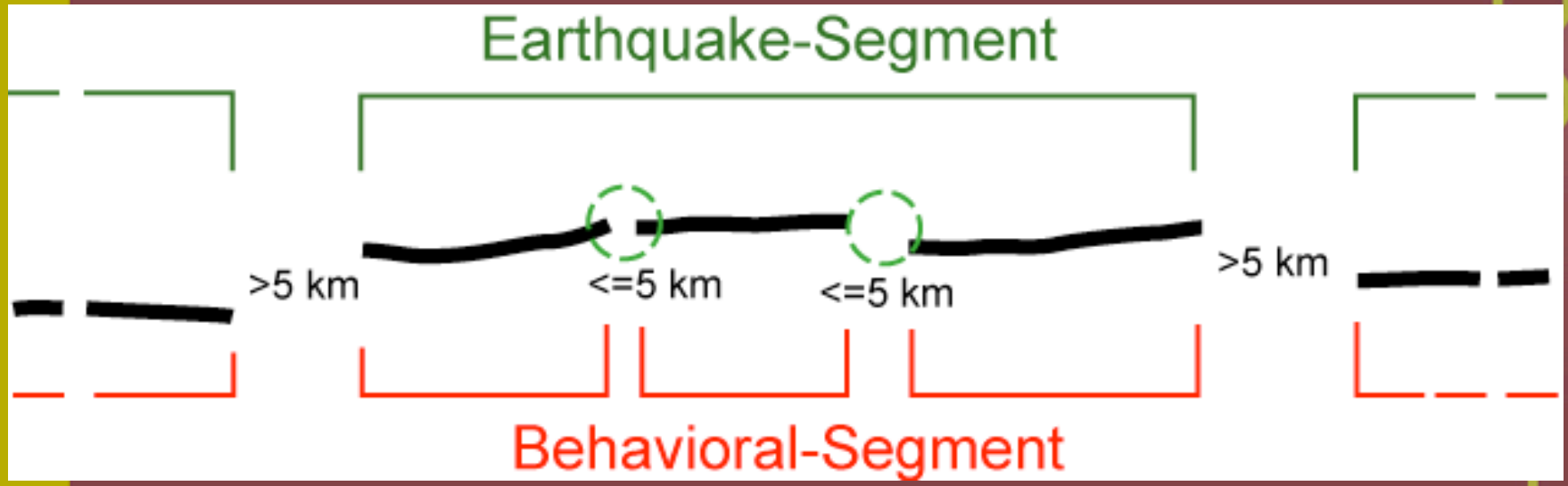
- 431 behavioral-segments;
  Length >= 10 km,
  Slip rate >= 0.1 mm/y
- Maximum length :60 km
  Average length: 21km

Behavioral segment

Fault geometry
Timing of paleo-faulting
Slip rate



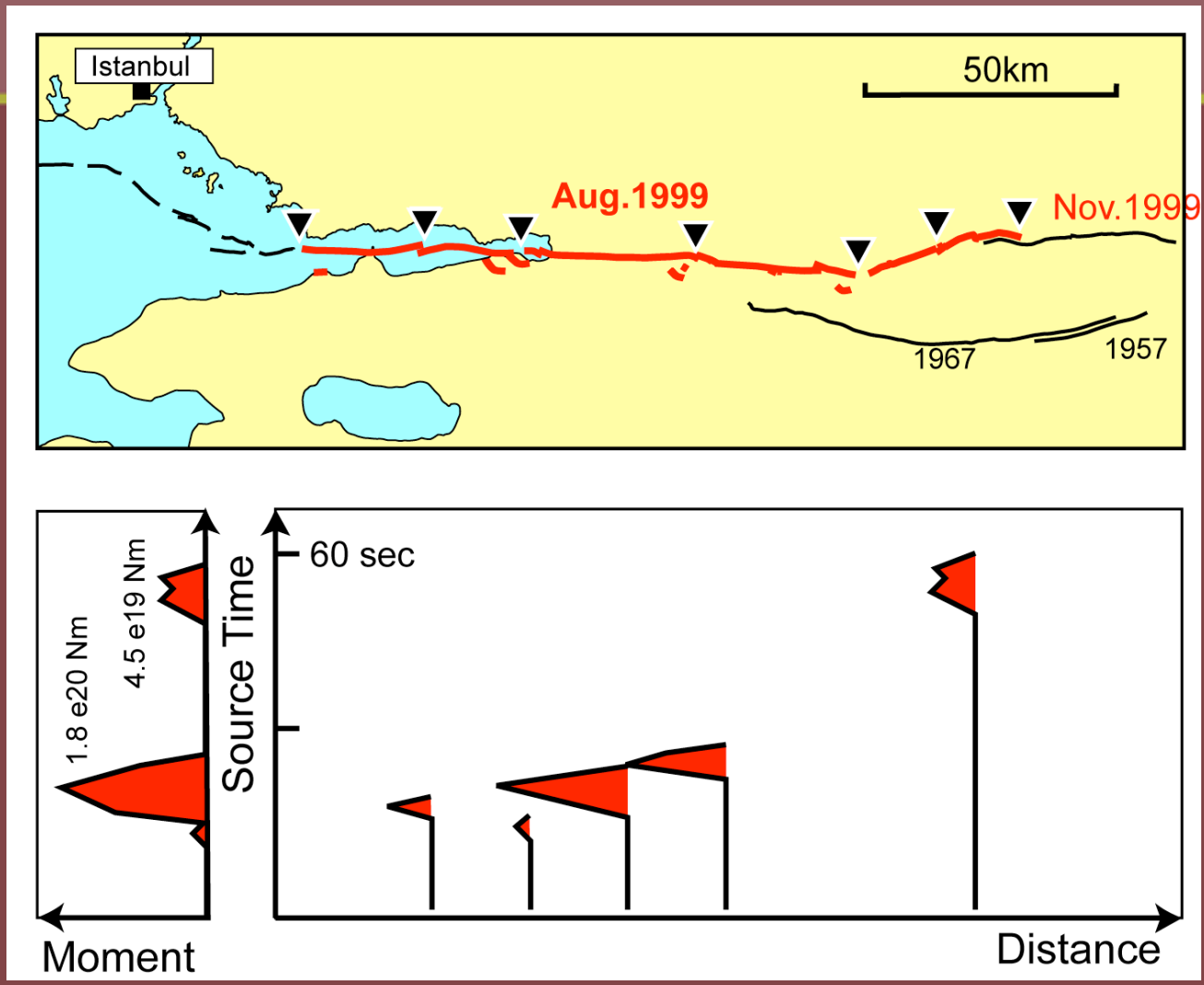
"Best-Estimation" of Earthquake-Segment



- **Segments with a gap <= 5 km** are contagious to each other
  (Matsuda's (1990) criterion)

- **431 b-segments** are reconstituted into **256 earthquake segments**
- Each of major 145 earthquake-segments (>= 20 km) is consists of ca.2 behavioral-segments in average
- Maximum earthquake-segment consists of 15 behavioral-segments

Multi-Segment Rupture of 1999 Ismit Eq.



- 1995 Izmit Earthquake (Mw 7.4) L = 150 km, Dmax = 5.2 m
- Geologically 6 behavioral-geometric segments
- Seismologically 5 - 6 subevents

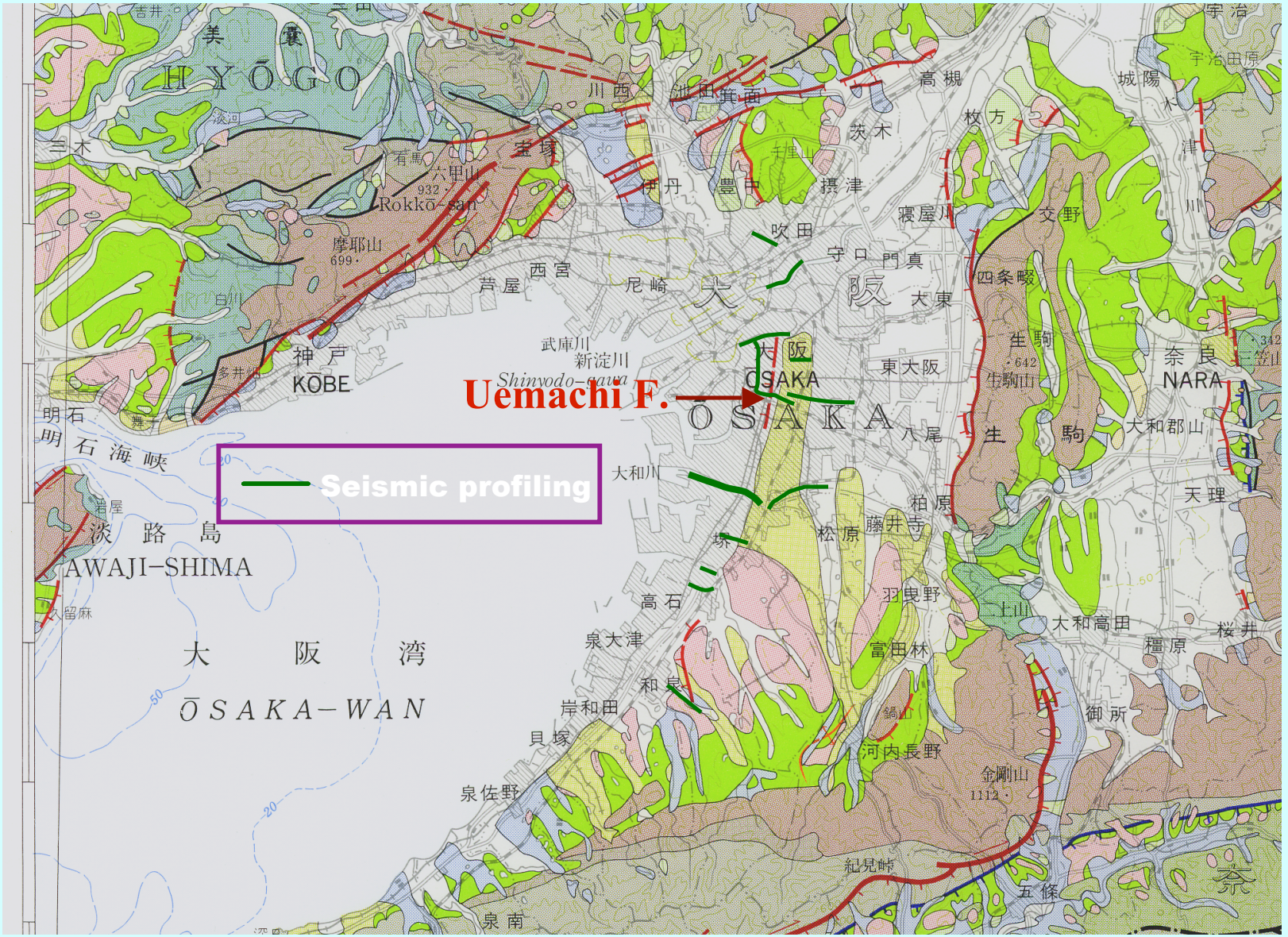
Satellite Image of Osaka Area

10 million people are living in the Osaka plain including Kyoto basin.

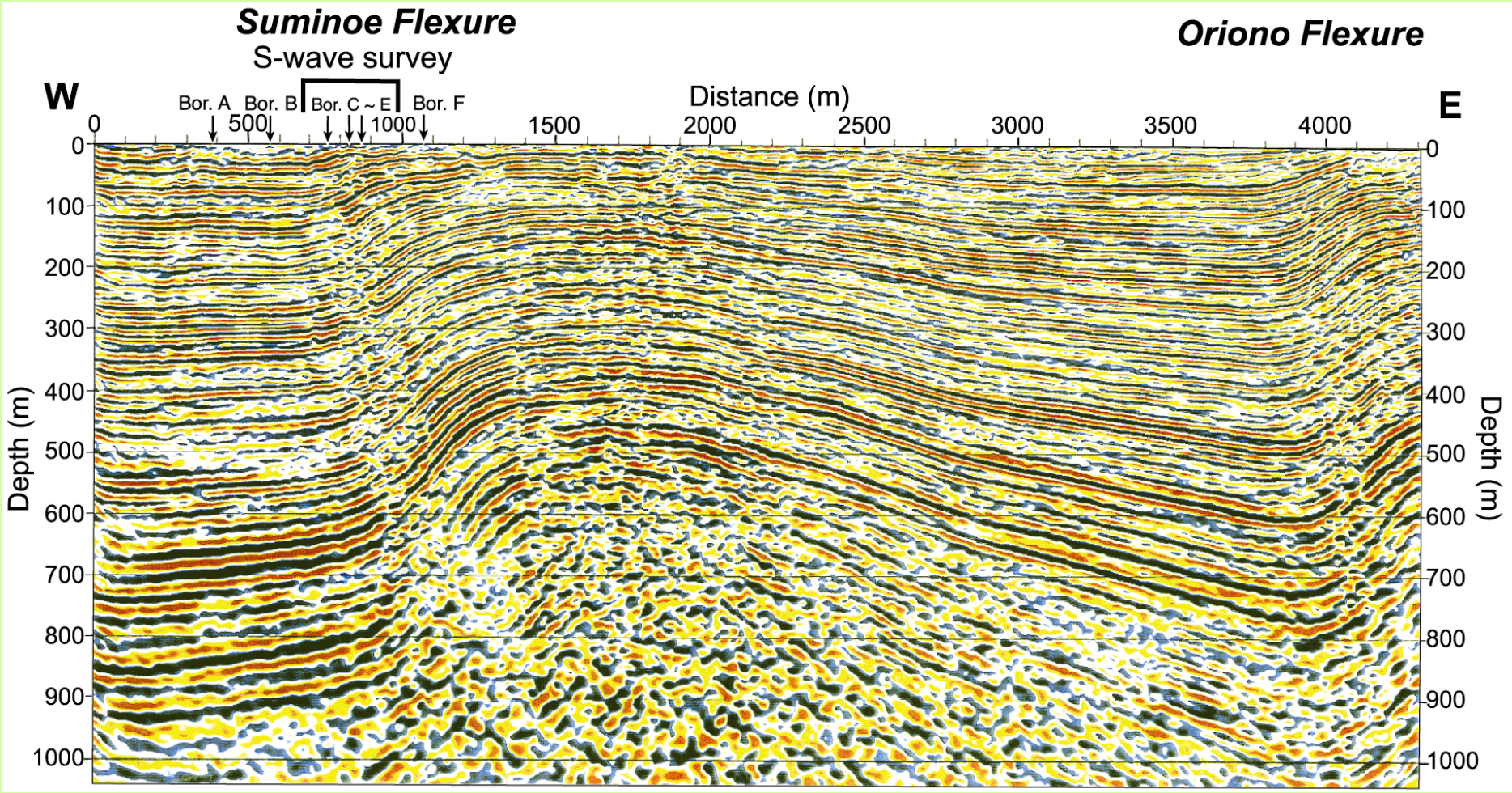
JAPEX GEOSCI. INST.

Our knowledge about Uemachi fault in 1980s Neotectonic

Map Kyoto 1st Edition (1983)



P-wave Reflection Profile of the Uemachi Fault System in South Osaka



Our present knowledge about Uemachi fault

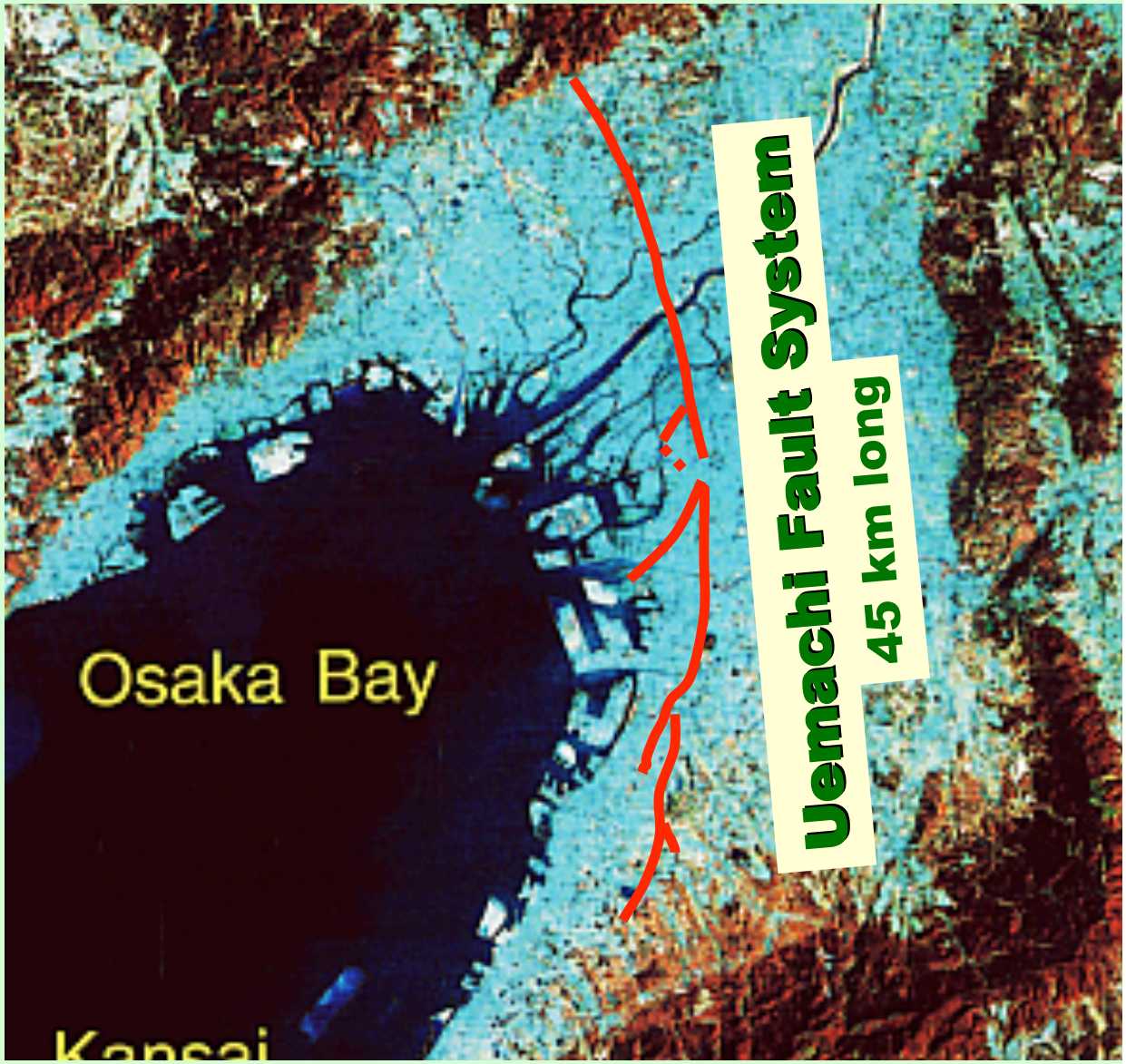
Neotectonic Map Kyoto 2nd Edition (2002)

National evaluation for future earthquake from Uemachi Fault System

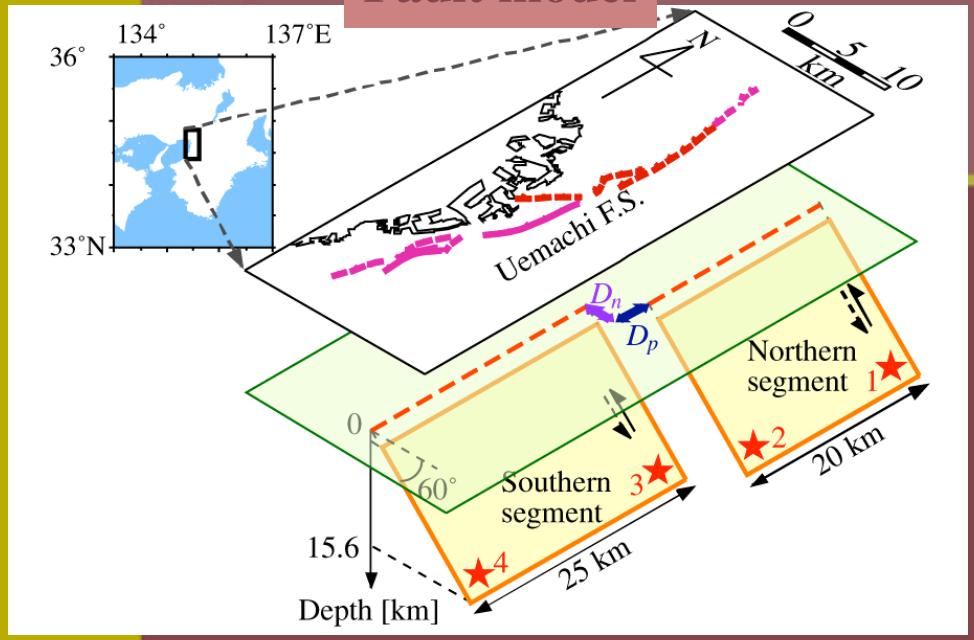
Magnitude: 7.5±

30y prob. : 2~3%

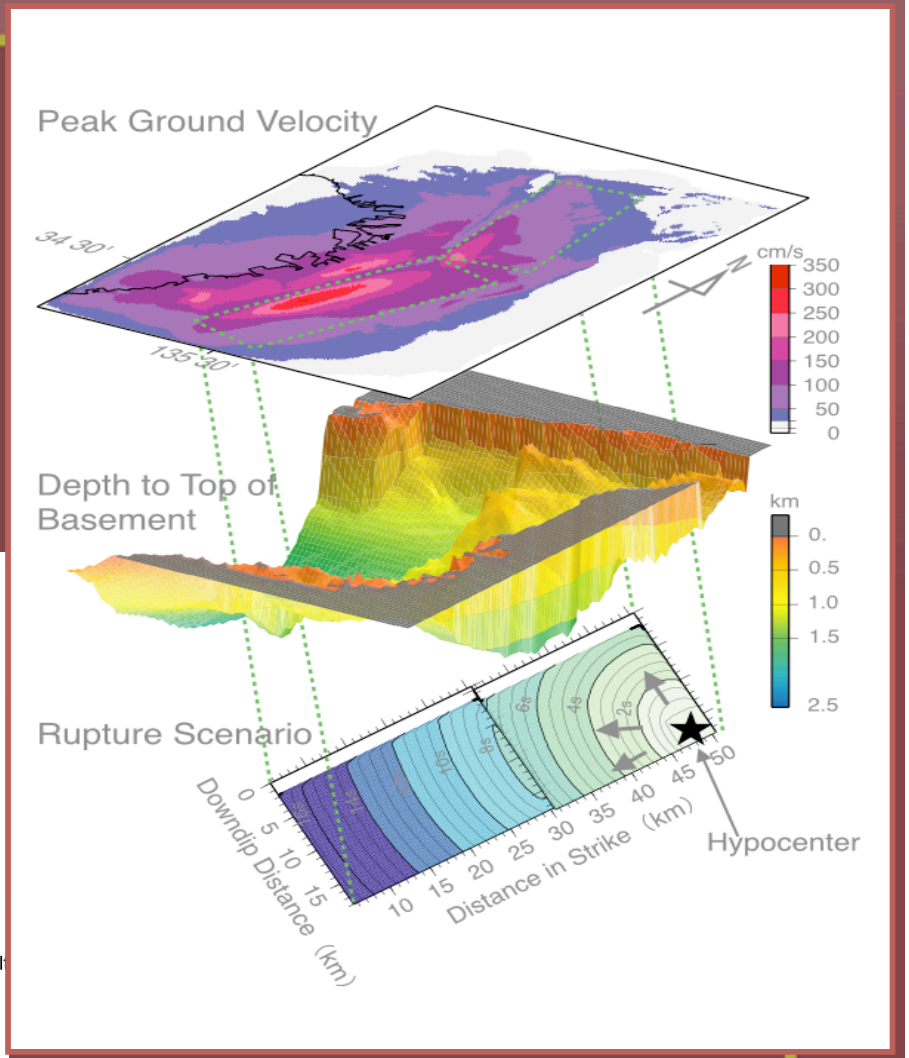
100y prob. :6~10%



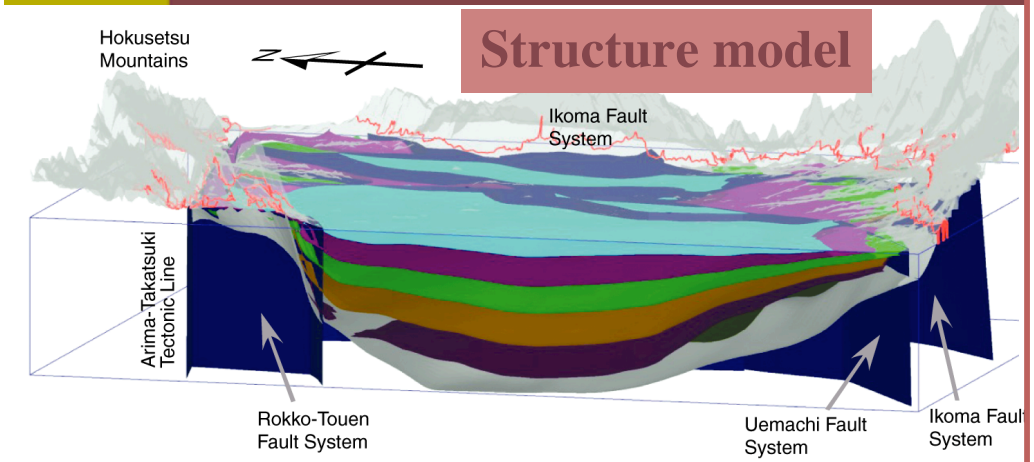
Fault model

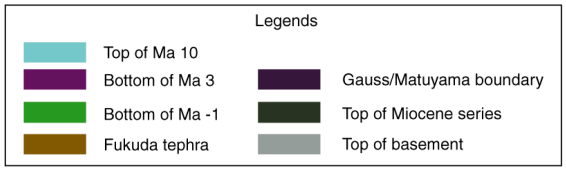


Strong ground motion simulation



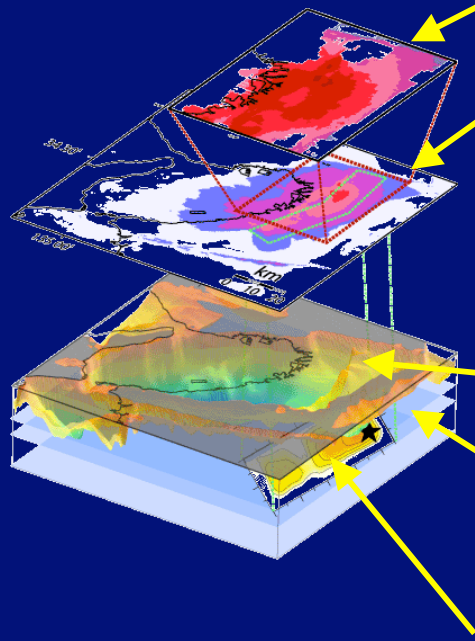
Structure model





第7図．3次元地質構造モデルの可視化例．大阪湾側から東を見たもの．
Fig. 7. An example of visualization of the three-dimensional geologic structure model. East view from Osaka Bay.

Computational Strategy



Low frequency

Ground motion computation

1D multi reflection theory

3D FDM simulation

Underground structure

Alluvium model

3D sedimentary basin model

Crustal model up to basement

Source

Active fault

Dynamic rupture simulation (FDM) Geological information

Interplate, intraslab, M6-class intraplate

Kinematic source model

~0.5-1.0Hz

High frequency

Stochastic simulation

1D sedimentary layer model

High frequency source

Outline

Earthquake Scenarios on Active Faults

- **Dynamic rupture simulation**
  - **Heterogeneous slip distribution inferred from past earthquakes**
- **Application to Uemachi fault system**

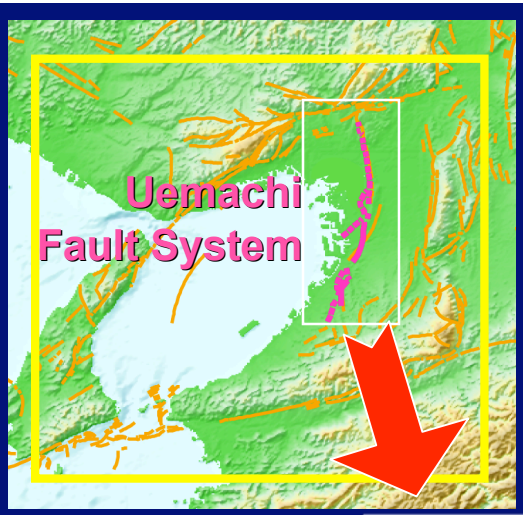
3D Osaka Sedimentary Basin Structure Model

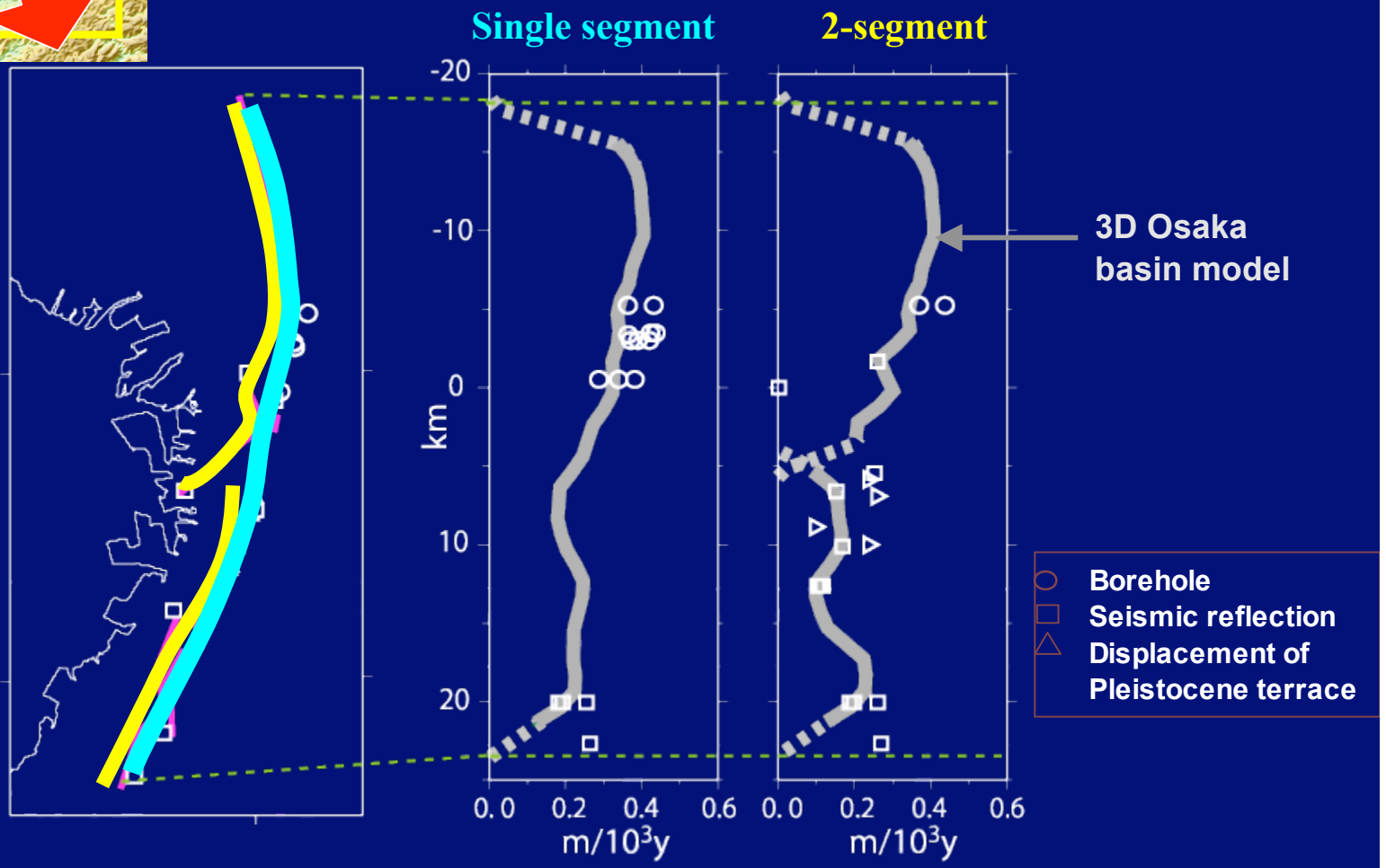
- Features
- Calibration of the model using seismic records

Ground Motion Simulations

- Uemachi fault system

Average Uplift Rate Distribution along Uemachi Fault System





Slip and Static Stress Drop Model → Earthquake Scenarios

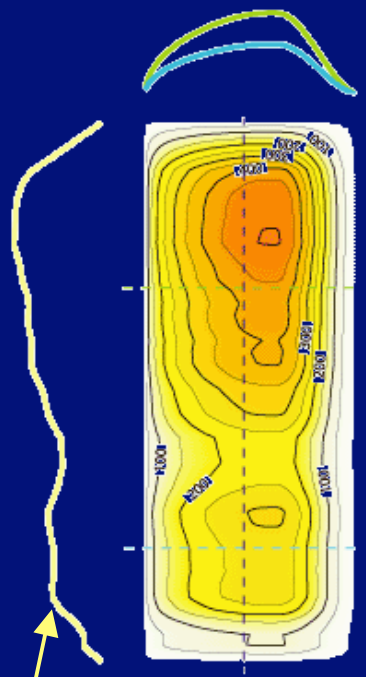
Slip → Static stress drop → Strength distribution

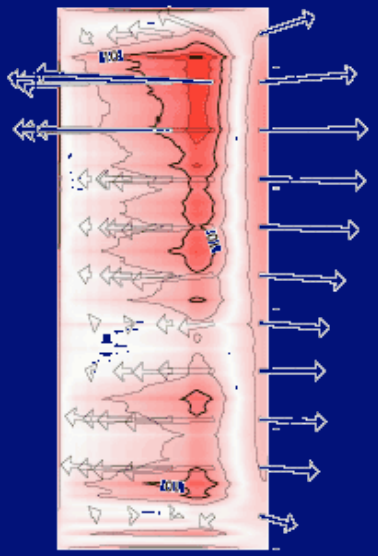
Earthquake scenario

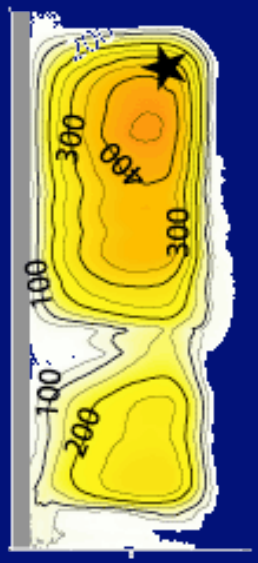
Dynamic rupture simulation (FDM)

Slip

Rupture time



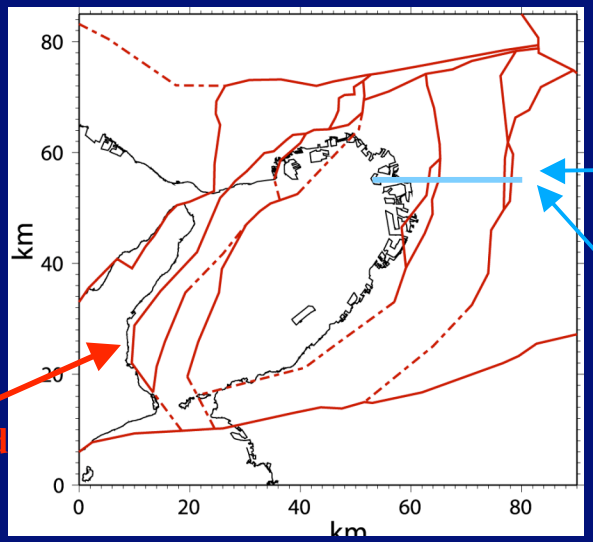




~ Average uplift rate distribution

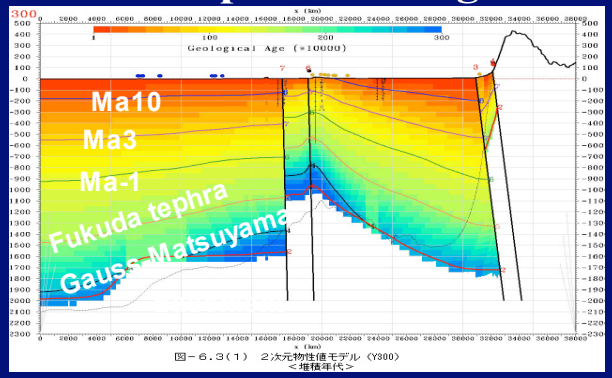
Features of 3D Osaka Basin Structure Model

Geologic block

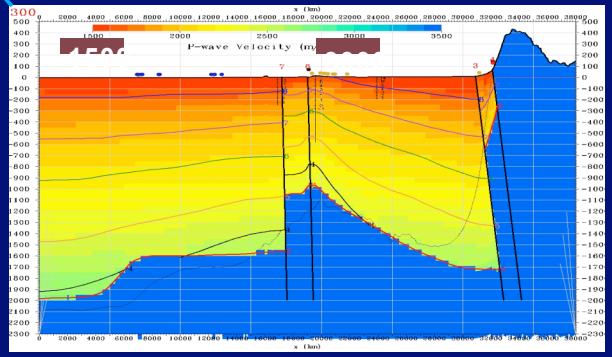


Major faults and their extensions

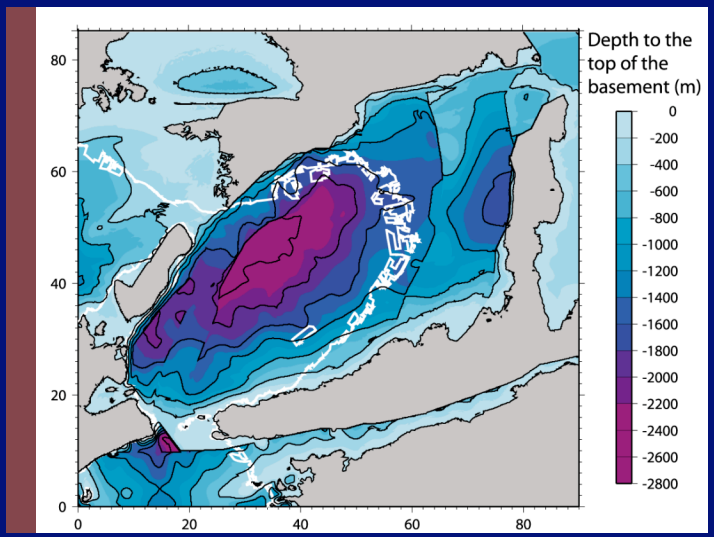
Distribution of key layers and depositional age



Distribution of Vp



Depth to basement

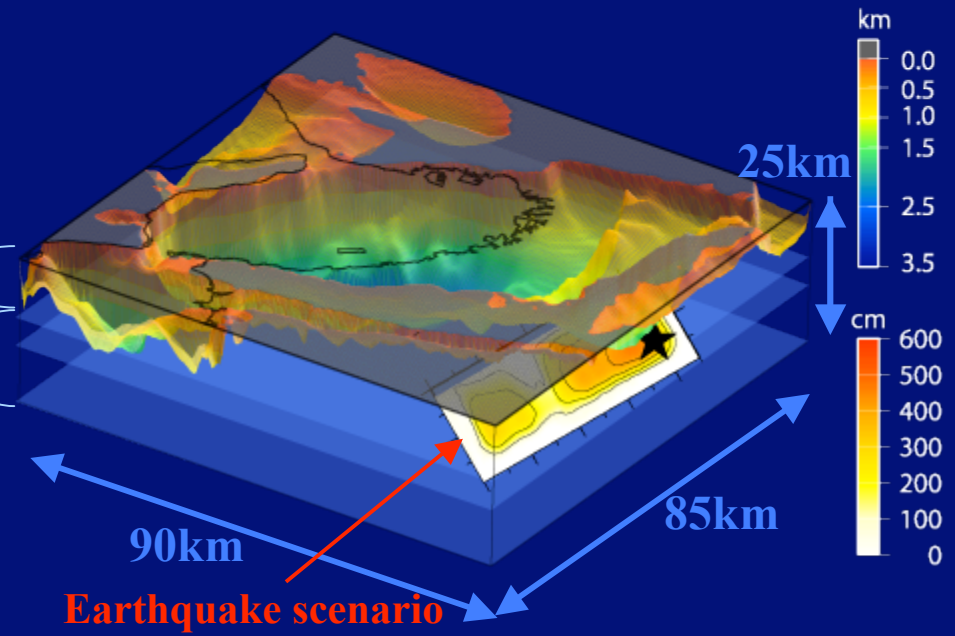


Medium constants model (Vs, density) in 100m x 100m (horizontal) x 50m (vertical) mesh data

Ground Motion Simulation

Up to engineering basement (Vsmin:0.55 km/s)

- 3D FDM (Pitarka, 1999)
- 3D underground structure model
- ~1Hz
- dxmin: 100 m



Osaka basin model

1D layered model
(Maeda and Watanabe, 1984)

Ground Motion Simulation

Up to engineering basement (Vsmin:0.55 km/s)
- 3D FDM (Pitarka, 1999)
- 3D underground structure model
- ~1Hz
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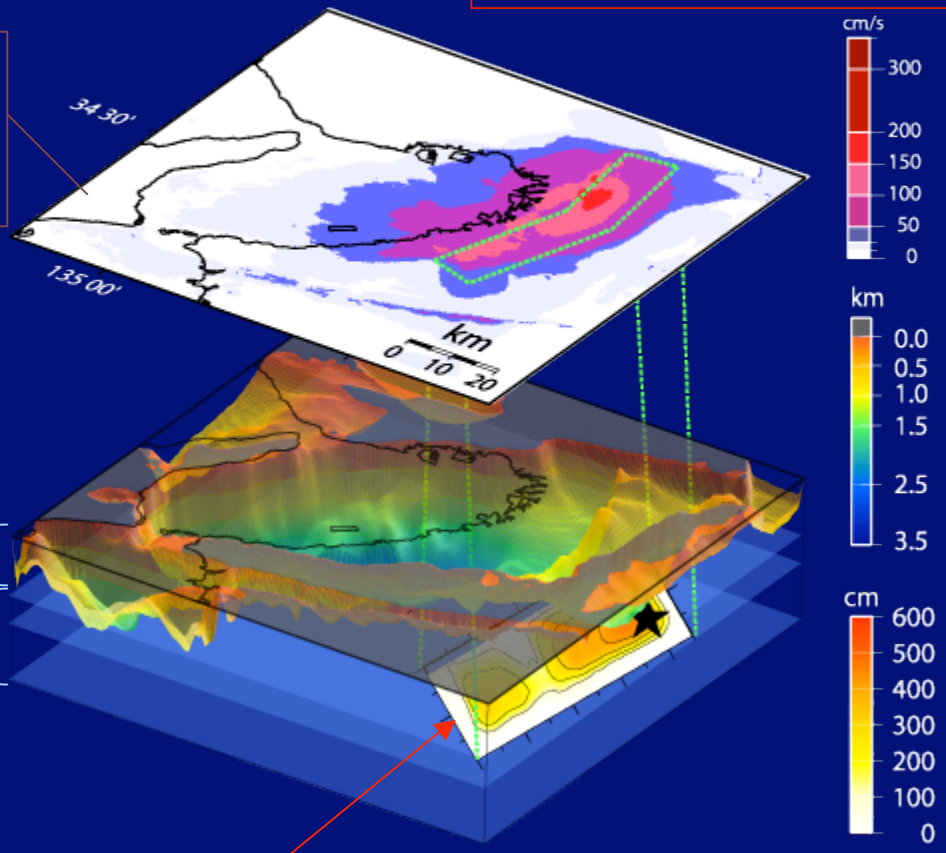
Peak ground velocity at engineering basement



Osaka basin model

1D layered model (Maeda and Watanabe, 1984)

Earthquake scenario

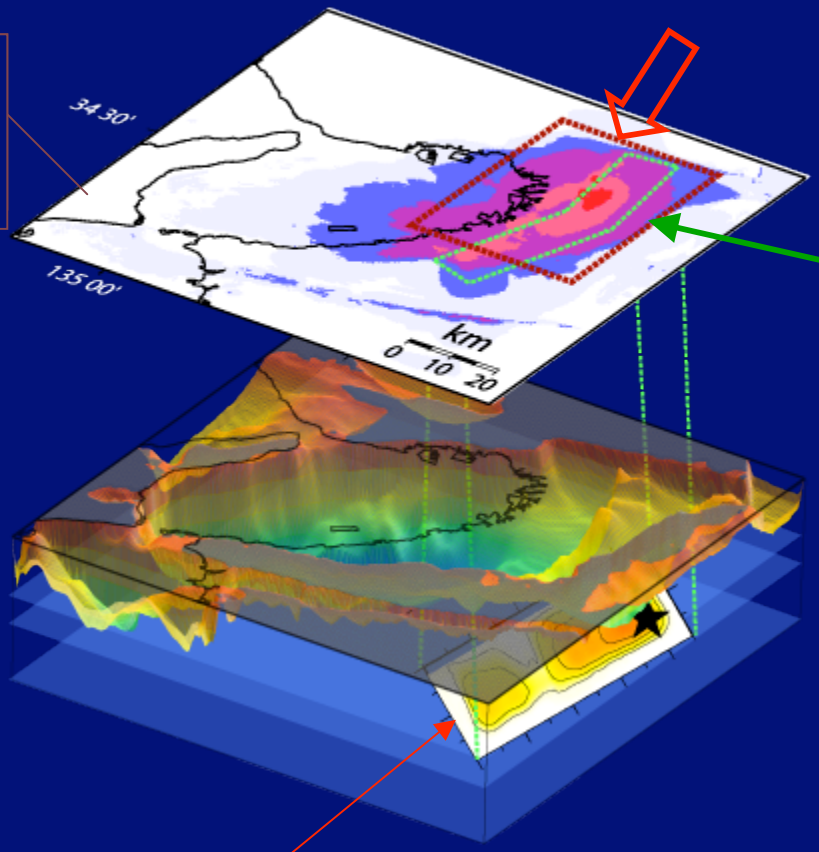
Ground Motion Simulation

Effect of shallow sedimentary layers

1D multi-reflection theory

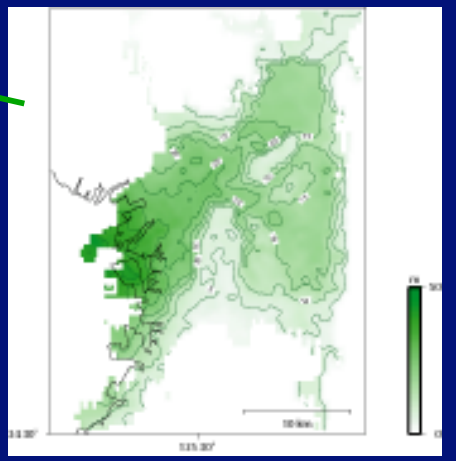
DYNEQ (Yoshida and Suetomi, 1996)

Peak ground velocity at engineering basement



Earthquake scenario

Thickness of alluvium layers



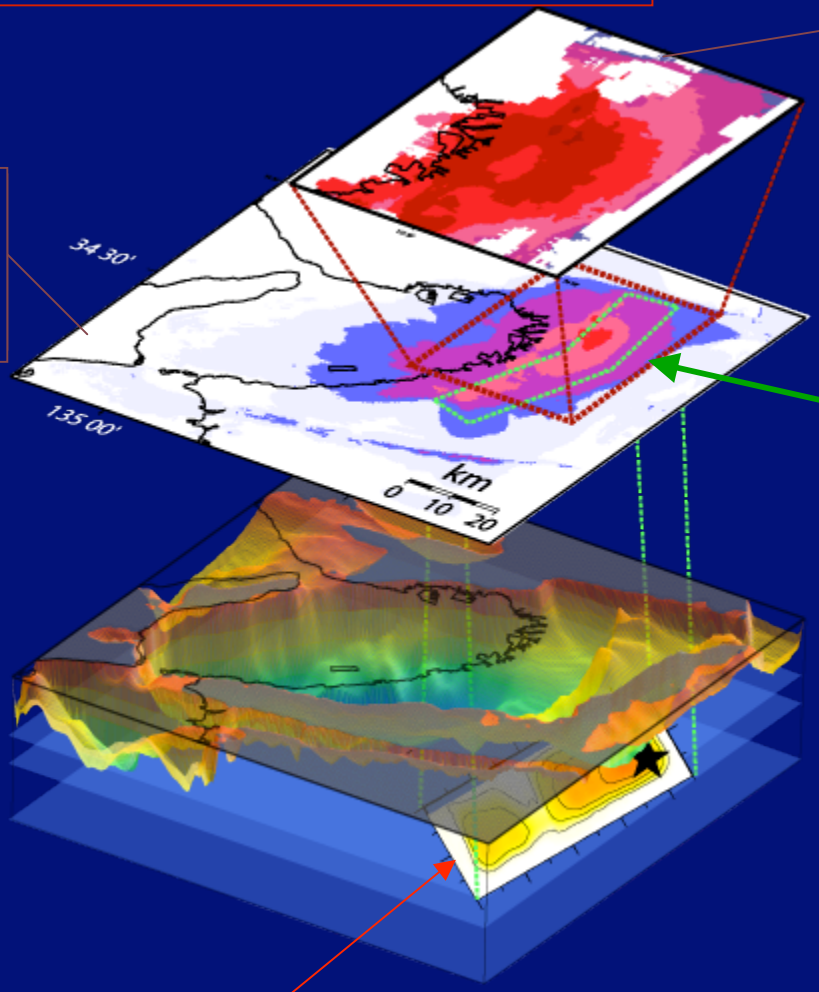
Yamamoto (2003)

Ground Motion Simulation

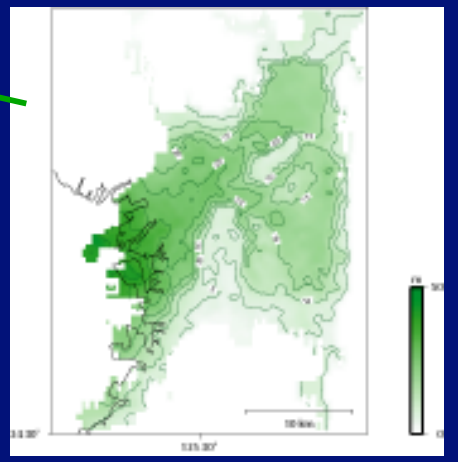
Effect of shallow sedimentary layers
1D multi-reflection theory
DYNEQ (Yoshida and Suetomi, 1996)

Peak ground velocity including effect of shallow sedimentary layers

Peak ground velocity at engineering basement



Thickness of alluvium layers



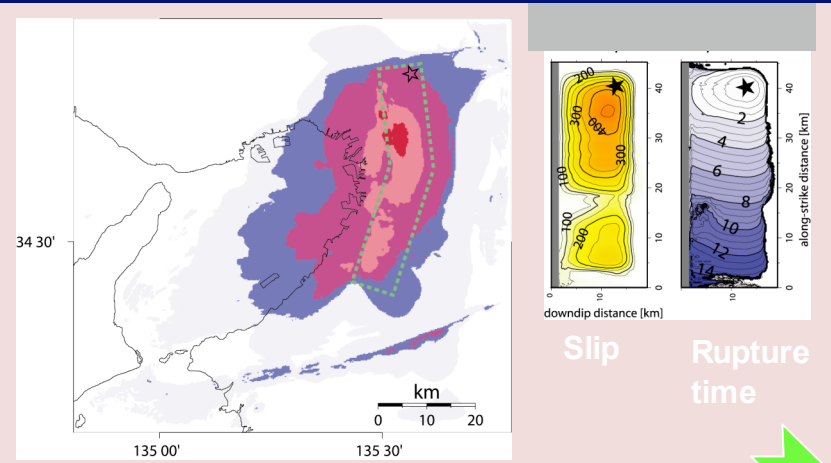
Yamamoto（2003）

Earthquake scenario

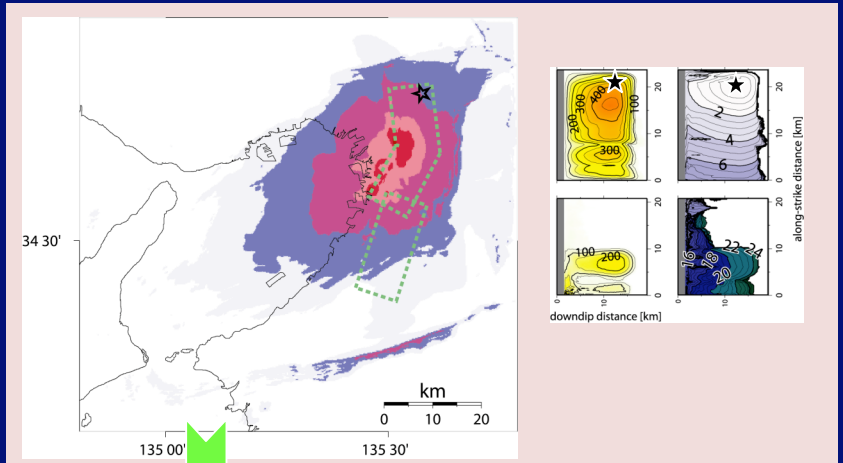
Peak Ground Velocity for Different Scenarios

(on engineering basement)

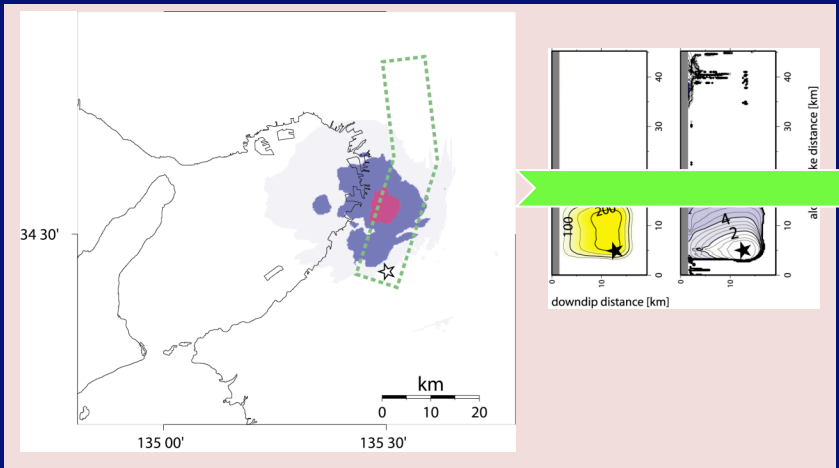
Single segment model,
Hypocenter near the northern margin of the fault



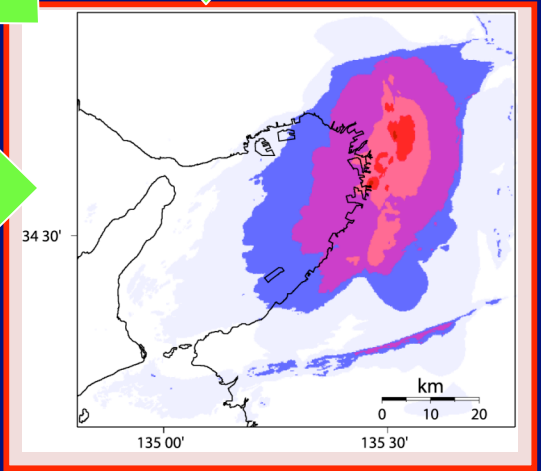
2-segment model,
Hypocenter near the northern margin of the fault



Single segment model,
Hypocenter near the southern margin of the fault



Max. of peak ground motion of all the scenarios



Shaking map for Uemachi fault system

For more information

- **Active fault:**
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- **Dynamic rupture simulation:**
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- **Ground motion simulation:**
  haruko.sekiguchi@aist.go.jp